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A new model of MHD Magnetic Reconnection in High Magnetic Reynolds Number Plasmas

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I present a new model for the time evolution of fast magnetic reconnection in a free space, which is specialized for astrophysical applications and is characterized by self-similarity. The possibility of this type of evolution is verified by numerical simulations. We also find an analytical solution which is consistent with the numerical result. The reconnection rate of this model is spontaneously determined by the reconnection system itself by the form of the self-similarly expanding outflow structure. In many cases of astrophysical problems, e.g., solar flares or geomagnetospheric substorms, the spatial scale of the reconnection system significantly expands as time proceeds. The resultant spatial scale of the reconnection system can be much larger than the initial scale. (A dynamic range on the order of 7 magnitudes is typical). Such evolution should be treated as a spontaneous evolution in a free space. In spite of this, most previous works focused on the character of evolution strongly affected by artificial boundary conditions (so-called "driven reconnection"). The focus of this work is on this spontaneous expanding phase. Our theoretical contribution is to establish a new model for magnetic recreconnection based on a more realistic evolution which incorporates the spontaneous formation of a freely expanding structure.

Keywords: Magnetic Reconnection, MHD